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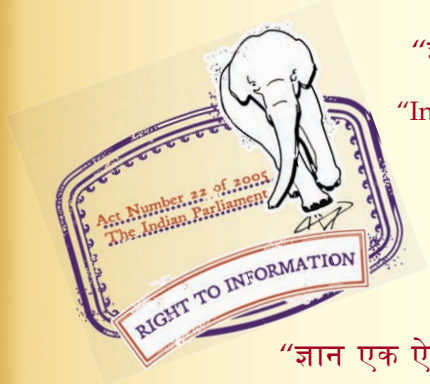
IS 11710-1 (2005): Selection and design of diamond core drills - Code of practice, Part 1: Mechanical Drive [MED 21: Diamond Core and Waterwell Drilling]



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हीरक कोर वेधन के चयन और डिजाइन की रीति संहिता

भाग 1 याँत्रिक चालन

(पहला पुनरीक्षण)

Indian Standard

SELECTION AND DESIGN OF DIAMOND CORE DRILLS — CODE OF PRACTICE

PART 1 MECHANICAL DRIVE

(First Revision)

ICS 73.100.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2005

Price Group 3

FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Diamond Core and Water Well Drilling Sectional Committee had been approved by the Mechanical Engineering Division Council.

The criterion laid down in this standard generally used for exploration, mining, drifting, foundation testing, grout drilling and soil/strata investigation may serve as guideline for use by the manufacturers and the users of diamond core drills.

This standard was first published in 1986 for mechanical drive only. The experience gained in the industry necessitated revision of this standard incorporating technological changes during past few decades.

With more and more technological advances made in the field of hydraulics and automation, top hydraulic drills are being used world over for exploration of minerals as well as geo-technical investigations. It has been thought fit to bring out a standard for selection and design of top drive hydraulic drills. Thus, in this revision, this standard has been brought out into two parts. The other part in the series is:

Part 2 Top drive hydraulic (*first revision*)

Indian Standard

SELECTION AND DESIGN OF DIAMOND CORE DRILLS — CODE OF PRACTICE

PART 1 MECHANICAL DRIVE

(First Revision)

1 SCOPE

This standard (Part 1) covers selection and design criterion for diamond core drills generally used for:

a) Exploration of all minerals including coal;

b) Mining and other allied drilling jobs including drifting and tunneling; and

c) Investigations connected with foundation testing, grout drilling soil and strata investigations.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2266 : 2002	Steel wire ropes for general engineering purposes — Specification (*fourth revision*)
10208 : 1982	Diamond core drilling equipment — Specification

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definitions shall apply.

3.2 Maximum Hook Load

3.2.1 Maximum hook load is defined as:

a) Weight of drill string at maximum drill capacity (for the maximum depth attainable by the drilling machine) when suspended in the air. The weight of conventional (*W*) and wireline (*Q*) series rods are given in Table 1.

b) Load, which could be on account of casing string when running casing in the hole.

c) Load during fishing jobs caused by stuck up drilling string.

3.2.2 For defining the capacity of the drill, the weight of drill string shall be considered as defined in **3.2.1**(a) and other conditions as defined in **3.2.1**(b) and **3.2.1**(c) are taken care of by a suitable factor of safety.

Table 1 Weight of Drill Rods

(*Clause* 3.2.1)

Sl No.	Size Code[1)]	Weight of 3 m Long Drill Rod with Coupling kg
(1)	(2)	(3)
i)	HW	38.8
ii)	NW	24.5
iii)	BW	19.2
iv)	AW	15.5
v)	HQ	34.9
vi)	NQ	23.6
vii)	BQ	18.2
viii)	AQ	14.1

[1)]For size code, IS 10208 may be referred.

3.2.3 Weights indicated for '*Q*' designated series rods are typical. The weights of other '*Q*' designated series may be as agreed to between the supplier and the purchaser.

4 SELECTION CRITERION

4.1 The selection of a diamond core drill depends mainly upon the depth to be drilled and the minimum core diameter required at the final depth. Other selection parameters such as type of prime mover, mounting, transmission, drive, swivel head, feed arrangement and optional assemblies like wireline hoist, hydraulic chuck, rod handling arrangement, type of control, recording mechanism, mast depend upon individual requirement which are detailed in relevant clauses of this standard.

4.2 Construction of drill, however, depends upon location of use and type of operating system.

a) Depending on location:

i) Surface, and

ii) Underground.

b) Depending on operating system:

The mechanical drive shall also have some hydraulic operation such as feed, retraction, chuck, and drive for wireline hoist.

The variant in operating system shall be applicable to both surface as well as underground drills.

5 SELECTION AND DESIGN OF SURFACE DRILL

5.1 Capacity of Drills

5.1.1 Capacity of the drill is usually defined by maximum hook load, which can be safely handled by the hoisting system of the drill as defined in **3.1.1**. The standard capacity ranges are indicated in Table 2.

5.1.2 The capacity of the derrick / mast shall be twice the maximum weight capacity of the drill rods. The depth capacity of the drill in other rod sizes will depend on practical field conditions.

5.1.3 For depth ranges other than those mentioned above, the capacity would be decided by mutual agreement between the purchaser and the manufacturer.

5.1.4 Capacity of the drill should also be considered for selection of suitable circulating fluid pump for which separate Indian Standard is available.

5.1.5 Although, drilling is the main function of a core drill, its capacity is generally specified by the weight of the drill string it is able to hoist. This is so because the power required for hoisting operation is higher than that required during actual drilling operation. Further, maximum stresses are developed in components of the transmission mechanism during hoisting and hence the hoisting operation is more critical for design consideration.

5.2 Mounting

5.2.1 Normally the types of mounting as given in **5.2.1**, **5.2.2**, **5.2.3** and **5.2.4** are used for surface drill.

5.2.2 *Truck Mounted*

When the terrain for drilling is plain and manoeuverability is easy, it is advantageous to have a truck-mounted drill particularly for medium and deep capacity drills, say over 6 000 kg. The advantage of truck-mounted drill includes quick transportation and erection of drills by using mechanical or hydraulic jacks. The disadvantage in this type of mounting is that the drill cannot negotiate steep gradients and undulated terrain. It is difficult to drill angular holes. Moreover the initial cost and the cost of maintenance of truck is higher.

5.2.3 *Trailer Mounted*

Drills mounted on trailer may be used conveniently in the same terrain as mentioned in **5.2.1**. Normally extra heavy drills of over 15 000 kg capacities are mounted on trailers. In this arrangement a separate towing vehicle is required to tow the trailer.

5.2.4 *Skid Mounted*

5.2.4.1 This is the most commonly used type of mounting due to its versatility by having self-towing arrangement, both in the front and rear. It can negotiate any terrain on its own power.

5.2.4.2 The skid base shall be rigid, steel structural frame so that the unit is able to negotiate gradients of 1 in 4 under its own power without losing its stability. Skid surface shall be large enough for self-propelling of the unit. Construction of the base shall be of adequate strength to bear the weight of the unit and also to overcome the wear and tear due to skidding during transport. Optionally brass wear plates may be provided on the skid to take care for the wear and tear during retraction.

5.2.4.3 The skid surface shall be so designed that it does not cause any obstruction during angle hole drilling. If necessary, detachable front toes may be provided to achieve this aim.

5.2.4.4 On the requirement of the purchaser, an arrangement for sliding the prime mover on the skid

Table 2 Capacity of the Drills

(*Clause* 5.1.1)

Sl No.	Capacity Designation	Maximum Capacity kg	Pulling Rod Size	Depth m
(1)	(2)	(3)	(4)	(5)
i)	Low	1 500	NW	150
ii)	Low	3 000	NW	300
iii)	Medium	6 000	NW	600
iv)	Heavy	10 000	NW	1 000
v)	Heavy	15 000	NW	1 500

may be made by the manufacturer for the ease of maintenance of drill assemblies. The skid can be made longer so that engine may slide back or any other design as per mutual agreement between the purchaser and the supplier.

5.2.5 *Crawler Mounted*

Crawler-mounted rigs can be used in suitable terrain.

5.3 Power Requirement of the Drill

5.3.1 The power required for the drill shall be provided by an engine of adequate capacity and speed. The power required for a given capacity shall be calculated by the following formula:

$$P = \frac{K \times H_L \times V}{\eta \times 4\,500} \times 0.745$$

where

P = power required, in kW;

K = 1.33, a constant for fishing and running in casing load;

H_L = maximum hook load, in kg;

V = minimum hoisting speed, in m/min, say 30 m/min; and

η = efficiency of mechanism, 75 percent.

5.3.2 For drilling operation in plain terrain, most of the drills are powered by diesel engines. In case of operations in high altitude areas, a suitable factor is to be considered to take care of deration. Petrol engines may also be used in such areas as well as in some other cases where lightweight of the engine is preferred due to transport considerations. Electric motor as prime mover is feasible only in the places where surface drilling is to be carried out and electric power is available. Pneumatically operated drills are used under limited special applications where high manoeuverability is required.

5.4 Transmission

5.4.1 For surface drills of all capacities, the transmission will be through clutch and a heavy-duty gearbox with 4 forward and 1 reverse speeds in case of low capacity drills and 5 forward and 1 reverse speeds in case of medium and heavy capacity drills. The clutch shall be located either on engine or drill side. The clutch shall be mechanical or hydraulic type depending upon torque requirements based on capacity of the drill.

5.4.2 The drills shall be provided with speed range selector for high/low speed ranges. The range of speed of the spindle in respect of drills of different capacities is given in Table 3.

Table 3 Capacities *Versus* Speed Ranges

(*Clause* 5.4.2)

Sl No.	Capacity Range kg	Speed Range rpm
(1)	(2)	(3)
i)	1 500	200 to 1 000
ii)	3 000	160 to 1 200
ii)	6 000	25 to 1 250
iv)	10 000	25 to 1 250
v)	15 000	25 to 1 250

NOTE — Broad ranges are indicated in speeds. Minor changes could be agreed to between the supplier and the purchaser with the mutual consent.

5.5 Hoisting System

5.5.1 The hoist will have planetary gears to provide speed range from 20 m/min to 100 m/min for hoisting system. The clutch and brake drum shall be of adequate dimension to take full load at the rated capacity of the drill. The drum shall have a manually controlled clutch and brake system of adequate capacity. These may be covered to protect against entry of water, oil, dirt, etc. The clutch shall be on the left side of the operator and brake shall be on the right side of the operator for ease of operation.

5.5.2 The hoist drum shall be provided with adequate length of steel rope suitable for single line pull, to lift the rods as per the rated capacity of the drill. The steel wire rope shall be of multi-strand type, left hand ordinary lay, non rotating type, conforming to IS 2266. The size of the rope to be provided with the drum shall be as specified by the user. The winding of the rope in the drum shall be in such a way that the rope enters below the drum from the direction opposite of the controls.

5.6 Swivel Head

5.6.1 The assembly shall incorporate bevel gears, spiral bevel gears or hypoid gears running in oil bath/ grease. The head shall be capable of swivelling through 360° range. The swivel head shall be of A, B, N and H size codes. In case of drills of capacities up to 10 000 kg the drive spindle can be either circular or hexagonal while in the case of drills of capacities of over 10 000 kg, it shall preferably be hexagonal. The hydraulic cylinder shall be of adequate capacity with minimum 40 percent overload capacity and micro fine feed control device may be fitted to regulate the flow of oil. The feed length of drills with hydraulic feed shall normally be 610 mm.

5.6.2 The spindle shall be provided with a balanced chuck having 4 jaws operated mechanically or hydraulically or both. The mechanical chuck shall be provided at the bottom of the spindle and the

hydraulic shall be provided at the top of the spindle.

The hydraulic pump shall be of the constant volume or variable volume type of adequate capacity and pressure rating of 10 MPa. It shall be capable of running continuously to provide constant hydraulic pressure. The drive to the hydraulic pump shall be from the main gear box, power take-off (PTO) and a provision to engage and disengage the pump as per the requirement.

5.7 Rod Holder

The mechanical drill shall be provided with a suitable foot clamp to hold the string for the different size. Hydraulically operated rod holder may be provided, if required by the purchaser.

5.8 Retraction

The drill shall be provided with hydraulically retractable device for forward and backward movement of the entire drill unit with prime mover so that the machine is clear off the bore hole to facilitate running down of drill string.

5.9 Instrumentation and Controls

5.9.1 All control levers of the drill and the prime mover shall be conveniently grouped at a control panel for ease of operation. Drills shall be provided with following instruments / controls:

a) Bit rpm meter,

b) Bit load or weight on bit meter,

c) Relief valve,

d) Micro feed valve,

e) Emergency stop switch,

f) Depth meter,

g) Penetration rate meter, and

h) *Time recorder* — The prime mover shall be provided with a system to record the actual running time.

5.9.2 *Testing of Drill*

The testing facilities for testing the capacity of the drill shall be provided by the manufacturer.

5.9.3 *Auxiliary/Optional Components*

a) *Cat head* — Cat head may be provided as an optional attachment, if required by the purchaser. It shall be top/side mounted with engagement and disengagement control. It shall be properly located for ease of operation and shall provide for variable rotational speed.

b) *Wire line hoist* — Built-in type mechanically/ hydraulically driven wire line hoist with suitable power take-off incorporating a clutch, brake and an operating lever. In case of hydraulic operated hoists no clutch and brakes are required as hydraulic circuit provides these operations.

c) *Recording system/indicators* — Recorder for drilling parameters shall be provided as per requirement of the purchaser.

d) *Lighting system* — Lighting system shall be through the power source of the drill.

e) *Tools* — Adequate tools for operation and maintenance of the drill.

f) *Hydraulic test kit* — Hydraulic test kit comprising of pressure meter, flow meter regulating valve and necessary hoses.

g) *Mud test kit* — Mud testing kit comprising marsh funnel, mud balance, filter press, sand content measuring tube and *p*H meter.

6 UNDERGROUND DRILLS

6.1 Underground drills operate in a different environment and in hazardous conditions as compared with that of surface drills. The headroom available for operation of each drill is also limited. The selection and design of components shall conform to the requirements of statutory Act(s), Rules and Regulations relating to operation of equipment in mines. Therefore, above points need special consideration while designing and selecting drills for underground usage.

6.2 The capacity ranges, in kilograms, of drills for underground use with AW rods in single line operation defined in **3.1.2** shall be as given in Table 4.

Table 4 Capacity of the Drills

Sl No.	Maximum Weight/ Pulling Capacity kg	Rod Size	Depth m
(1)	(2)	(3)	(4)
i)	650	AW	100
ii)	1 000	AW	150
iii)	1 500	AW	250

NOTE — The underground rigs have to do some hole drilling work.

6.3 Mounting

Following types of mountings are used for drills for underground use:

a) *Column mounting* — This may be either single or double column. The height of the column shall be approximately 2 m depending upon the height of the gallery.

b) *Skid mounting* — The drill shall be mounted on skid base of rigid steel construction with sufficiently large skid surface for easy movement.

6.4 Prime Mover

6.4.1 Most of the drills are generally powered by compressed air, alternately electrically or hydraulically operated drills may also be used. If permitted by statutory regulations, diesel engine powered drill may also be used. In case of hazardous atmospheres, flameproof electrical motors shall be used as prime mover for drills.

6.4.2 *Power Requirement*

The power required for a given capacity shall be calculated by the following formula:

$$P = \frac{K \times H_L \times V}{\eta \times 4\,500} \times 0.745$$

where

P = power required, in kW;

K = 1.6, a constant for fishing and running in casing load;

H_L = maximum hook load, in kg;

V = minimum hoisting speed, in m/min, say 20 m/min; and

η = efficiency of mechanism, 75 percent in case of mechanical drills.

6.5 Transmission

6.5.1 The drive shall be either:

a) Single speed direct / top head drive, or

b) Through bevel gears, or

c) Through built-in 4 speed gear box.

6.5.2 In case of single speed direct / top head drive, the prime mover shall be provided with a throttle control to obtain variable speeds on drill spindle. If a built-in gearbox is provided, a clutch either of automotive type or industrial type of adequate capacity shall be provided for engagement and disengagement of the prime mover to the drill.

6.6 Hoisting System

The drill shall be provided with a pneumatically or hydraulically operated rod puller. Alternatively, a pneumatically, hydraulic or electrically operated winch may be provided. The pulling capacity shall be adequate for the full rated capacity of the drill.

6.7 Swivel Head

It shall be of AW size code and shall have either screw feed or hydraulic feed. The swivel head shall be capable of swivelling through an angular range of 360° and shall have built-in gears for providing at least three feed speeds for screw feed drills. The drive spindle shall be cylindrical and shall be equipped with a balanced chuck of 2 to 4 jaws at the bottom end.

6.8 Controls

All the controls of the drills shall be grouped at a convenient place for ease of operation.

6.9 Up-hole Drilling

In case of up-hole drilling, the capacity of pump has an important bearing on the capacity of the drill. There shall be provision of holding the drilling string while drilling up-holes.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 2323 0131, 2323 3375, 2323 9402 *Website :* www.bis.org.in

Regional Offices :		*Telephones*
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110 002	2323 7617, 2323 3841
Eastern	: 1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi KOLKATA 700 054	2337 8499, 2337 8561, 2337 8626, 2337 9120
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